MYTH BUSTERS
Oct-Dec 2006 publication “Swimming in Australia” magazine, vol. 23, no. 2
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What We Know About Training Is Changing Our Understanding of Lactic Acid

Myth or Fact? “High La_b concentration limits performance”

Swimming coaches have operated on the premise that Lactic Acid (La) production is both good and bad.

Good in the sense that measurable concentrations of lactic acid in the blood (La_b) that are above resting levels signal an increase in the production of energy via anaerobic pathways. This effect is ‘good’ because the rate of energy production is increased to meet the high demands of maximum effort swimming (i.e. fast swimming for a measured period of time).

This effect is ‘bad’ because the accumulation of La changes the pH balance (i.e. the measure of acidity) within the white muscle fibres.

What the science tells us:

- The change in pH is due to the release of positively charged hydrogen ions (H^+). As the chemical balance within muscle fibres becomes more acidic the rate of glycolysis slows because certain enzymes (note: enzymes act as a catalyst in the chemical reactions taking place) are blocked. There is also an impairment of the transmission rate of electrical signals from the motor neuron to the muscle fibre – the muscle fibre is slower to ‘relax’ following a contraction in preparation for the next contraction.

What the swimmer feels:

- The swimmer’s perceived response to high La production is a ‘muscle burn’, soreness, and tightening up of the muscle. Since coaches or sports scientists measure the chemical environment of blood, rather than muscle, we can only make well founded assumptions about what La_b figures tell us about what’s happening in the muscle.

What coaches do:

- Some coaches may take a simplistic view of the affects of lactic acid – they train their swimmers with frequent sets of high intensity swimming in an effort to improve the swimmer’s ‘tolerance’. Some coaches believe that ‘more is better’ in terms of work volume; so they prescribe large volumes of moderate-to-high (without being specific to race speed) aerobic work.

Some coaches recognise that an integrated approach to training requires the careful planning of volume and intensity and the recognition that sequencing of training effects is critical to training efficiency.

High blood lactate levels do not necessarily signal a performance limitation. Research over twenty or more years has confirmed that Lactate (i.e. La without the H^+) is actually used as a fuel by cardiac muscle. Lactic acid, circulating in the blood, is also converted back to glycogen by the liver. More recent research is now telling us that lactate is also used as a fuel in the mitochondria. The theory is that La moves from areas of high concentration (i.e. white muscle fibres) to areas of 'lower' concentration – in this case into the red muscle fibres. Lactate becomes a preferred fuel by the red fibres and because there is an oxygen supply the La is broken down more completely to yield carbon dioxide (CO_2) as a byproduct. CO_2 can then be carried by the blood to the lungs and is expired.

The established concept is that an 'anaerobic threshold' is reached by most athletes when La_b concentration is approximately 4mMol/L (this is traditionally an 'average' used in sports literature); signaling a shift in aerobic-anaerobic activity. However, this concept may be completely false. The 'threshold concept' ignores the adaptive process that takes place as a result of certain types of training. Specific training (and training patterns) can actually improve the rate of La removal and usage that occurs during performance requiring high energy output. If high La production is also matched by high La removal, the level of lactic acid in the blood may be significantly high yet a 'steady state' remains in the muscle environment. How fast lactic acid can be shunted away from the white muscle fibres becomes the important factor.

In addition, La reduction (i.e. utilization of lactate by red muscle mitochondria) is also occurring. It's possible for high steady-states of La_b to exist and be sustained for relatively long (i.e. several minutes) periods of time. The La_b concentration itself may not be the limiting factor. The more important factors are the removal and reduction rates and the depletion of glycogen stores that occur in the white muscle fibres. The myth that 'high' blood lactate concentrations are 'bad' may (at least in part) be <u>busted</u>.

Training Implications:

- Three types of training methods interact to stimulate improvement in the body's ability to remove or reduce La. The first method is Critical Speed (CS) training. The second is specific speed training, and the third is aerobic endurance training.

Although critical speed training has been referred to as "heart-rate" training; this is a misnomer, as all training at speeds eliciting heart-rates below maximum fall under this definition. Critical speed training is performed at intensities that stimulate a high, but sub-maximal, heart-rate response. The individual interval distance selected for use in a CS-set, the total volume of work per set, the

amount of partial-recovery time between intervals, and the frequency of application of this type of training are all factors that contribute to the overall training stimulus. Critical speed training helps train the body to remove La from white muscle fibres and reduce La by using it as a fuel in red fibre mitochondria.

The second type of training involves race specific speed – sometimes this is performed at race distance; 'quality' repeats at race distance with sufficient rest between repeats to maintain the desired speed. Sometimes the training involves 'broken' swims that simulate the total race speed pattern. Once again, the decision by the coach regarding 'how often' and 'how much' to apply this type of training will influence the swimmer's ability to adapt.

The third type of training provides the underpinning mechanism so that the first two types of training are adequately absorbed. Sufficiently high volumes of training that rely upon aerobic energy production serve to facilitate structural and functional adaptations of the circulatory system. Aerobic endurance training is performed at heart-rates that are well below maximum; it's the volume and frequency of such training that increases cardiac output, maxVO_2 , and capillary density around the muscle fibres. Aerobic training does not stimulate high La_b levels because the red muscle fibres are predominately used.

Fact or Myth? "Sprint and Endurance training are exclusive to the desired event"

Most swimmers are capable of quality performances over a wide range of competitive distances (i.e. from 100m to 800m). Although specialization of event distances may be necessary to focus on a swimmer's innate potential, the theoretical links between various principles helps us to explain why good performances in multiple events are possible. Coaches have always recognized that to achieve elite performance (even swimmers competing at 400-800m distances) a swimmer must have speed. Conversely, even swimmers training for 100-200m events must have endurance. The more we learn about lactate dynamics (i.e. the way La is produced, used, and accumulated) the stronger the links become between different training theories.

What science tells us:

- The principle of specificity of training suggests that to swim fast at shorter distances (i.e. 50m to 200m) the swimmer must train fast. To swim fast repeatedly a swimmer must have sufficient rest between successive swims.
- Endurance training principles suggest that high volumes of low-to-moderate intensity swimming, with only small amounts of rest, will increase cardio-respiratory capacity and efficiency.

What the swimmer feels:

- Both endurance and sprint training requires great effort and discipline, particularly with regard to maintaining ideal stoke technique when under pressure. The sprint swimmer knows that the most important part of his/her training is when fast swimming is required in training. However, the underpinning training (i.e. a mixture of training at various intensities and distances) seems less relevant, although it may be of equal importance. The endurance swimmer knows that to 'go the distance' he/she must complete substantial volumes of training. However, the need for specific speed and recovery training sets (i.e. thus reducing the total volume of training performed) is sometimes seen as a reduction in workload.

What coaches do:

- Once again, the coach's acquired experience and knowledge of training principles will dictate the type of training program presented. Two obvious facts must be applied when implementing a training program: (1) efficient training means that the optimal training load is applied, and (2) a swimmer can only absorb training that they can recover from.

The development of speed is essential because maximum velocity efforts serve to stimulate the white muscle fibres – this will not result from any amount of slow swimming. Appropriate stimulation from fast swimming serves to produce the desired adaptation in white fibres, increasing their capacity and efficiency. Coaches have known for many years that from the first day of a training cycle, through to the last day, every swimmer needs to swim with 'speed'. Naturally, the volume and frequency of training application is influenced by many other training variables. However, the fact remains that speed work is a core component in <u>every</u> swimmer's training. Coaching methods reflect this – we use 'High Velocity Overload' (HVO) training sets on a regular basis for all swimmers. Coaches also allocate specific sprint sets (usually repeat swims of 50m) on a regular basis. What we have learned from our 'new way' of looking at lactate is that the swimmer's aerobic capacity will enhance their ability to sustain high lactate levels (necessary for sustained speed through 100-200m events) because of adaptations that affect the removal and reduction processes. Aerobic efficiency is developed along with aerobic capacity because of a more efficient use of muscle glycogen. This is important, because muscle glycogen stores must be retained by the white fibres so energy is available when called for.

Along with continually developing speed, all swimmers will benefit from improvements in aerobic endurance capacity. The so called 'aerobic base' for training is not a myth – it becomes the platform for sustained improvements in both aerobic and anaerobic energy production. Increased endurance capacity (i.e. the ability to deliver oxygen, and then use it within the muscle) produces structural changes within the muscle and also to the circulatory system. Aerobic training also stimulates the development of the mitochondria in the red fibres –

and now it appears that this increased mitochondrial capacity is also a mechanism for reducing lactate.

Legendary coaches, including Carlile, Councilman, and Sweetenham have always advocated a strong aerobic platform as an essential component of long-term swimmer development. Sweetenham has also put forward his ‘Break Point Volume’ concept that tries to identify the optimal range of aerobic training during the critical years before and after puberty.

The myth that sprinters only need to sprint in training and that distance swimmers only focus on endurance training is definitely busted.

Training Implications:

- The old saying “nothing comes without dedication and effort” is certainly true. For a swimmer to achieve his/her potential they must work hard across a number of areas – swimming mechanics and mental preparation as well as physical preparation. Elite sprint swimmers must have sufficient training background to act as a platform for speed development. Long-term as well as short term training objectives must be put into place. It’s also true that the modern distance swimmer is successful because he/she is able to hold a high percentage of maximum speed for a longer period of time. Top class 400-800-1500m swimmers produce fast splits as a result of good training preparation.
- In addition to a focus on ‘lifetime’ training progressions, most swimmers will benefit from a ‘middle distance’ approach to training. This means developing the desired speed/endurance capacities to race well at 200m (all strokes) and then ‘fine tuning’ the emphasis on speed or endurance to compete well at 100m or 400m and above.
- Even the ‘drop dead’ 50m sprinter will benefit (perhaps not as much as other swimmers) from improved aerobic fitness and swimming efficiency. Improvement in 100m events will be a bonus from a sprint training program that develops peak sprinting speed at 50m as well as a measure of endurance.

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